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Optimal international trade agreements and dispute settlement procedures

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Abstract

This paper explores the limits of international trade cooperation in the presence of a dispute settlement procedure. The dispute settlement procedure is modeled as set of conditions imposed on the punishment equilibria of a repeated tariff game, conditions that are consistent with the WTO principles of conciliation and reciprocity. The resulting equilibria are "renegotiation-proof" in the sense of Pearce [Renegotiation-proof equilibria: collective rationality and intertemporal cooperation. Yale Cowles Foundation Discussion Paper: 855, Yale University, 1987]. We find that tariff agreements cannot achieve free trade in the presence of the dispute settlement procedure, although the cost of this limitation becomes small for high discount factors. Quota agreements can achieve free trade under the dispute settlement procedure; however, countries would always prefer to settle disputes with tariff sanctions, if given a choice. These results are related to recent dispute settlement reforms. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

Many international trade policies have the feature that if they profit the country employing them, they harm the rest of the world to an even greater degree. When every country has access to a policy of this type, there is always a cooperative

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arrangement to restrict the policy's use, which if could be enforced would benefit every country. In these situations, countries have an interest in cooperating with one another on trade policy to the greatest possible extent. An important limitation on this cooperation is that international trade agreements must be self-enforcing and hence must provide for sanctions against would-be violators, sanctions which themselves must be self-enforcing. To what extent sanctions can be meted out in the appropriate contingencies depends upon the extent of communication possible and the rules under which countries negotiate agreements and settle disputes. This paper explores the limits of self-enforcing international trade agreements and the effects of these rules, with a view toward identifying agreements yielding the highest levels of welfare to all signatories.

Recent literature has addressed the problem of trade policy cooperation by modeling the relationship between countries as a repeated game, demonstrating how a system of equilibrium sanctions can be used to support cooperation (see Staiger, 1995, for summary). Reversion to an interior Nash equilibrium of the associated stage game is the most popular form of sanction, though it generally does not result in the best agreement, in sense of supporting the lowest tariff levels for an arbitrary discount factor. In this respect, the bulk of the literature is lacking on both normative and positive grounds, unless a useful theory can be found to explain why countries would select inferior agreements. Following Abreu's (1983) work, Dixit (1987) and Ludema (1990) addressed the problem of finding optimal agreements, observing that the strongest credible sanctions generally involve prohibitive tariffs. A remaining question, however, is this: if countries were ever to reach a state in which sanctions were required, why would they not simply renegotiate the original agreement? However, if they renegotiate the agreement, what becomes of the sanctions and, indeed, the agreement itself?[1]

Avoiding sanctions through renegotiation in international trade agreements is not unusual. Virtually all international trade agreements provide their members with fora, in which to communicate their complaints, investigate perceived deviations and discuss the use of sanctions. The World Trade Organization (WTO) has an elaborate dispute settlement procedure (DSP) for gathering and transmitting information about perceived violations, facilitating negotiations between parties to a dispute, and deciding on sanctions. Since 1995, the WTO has been notified of over 200 disputes (World Trade Organization, 2000). Of the cases resolved so far, the majority were settled through negotiations between the countries themselves, without resort to adjudication. The bulk of the cases settled by adjudication have not resulted in sanctions. In the very few cases where sanctions have been imposed (three at last count), the *level* of the sanctions were determined through negotiation or arbitration and have been carefully circumscribed.

[1] Cotter and Mitchell (1990) address this issue, though their approach is substantially different from the one taken here.

A good example of this final category is the recent complaint brought against the European Communities by the United States, Ecuador, Guatemala, Honduras, and Mexico over the EC banana regime. Both the dispute settlement panel and the appellate body found against the EC. The EC subsequently modified its banana regime, but the modifications did not satisfy the complainants (or the panel). The United States asked the WTO for authorization to apply sanctions, in the form of tariffs on EC imports, valued at US$520 million. The EC objected on the grounds that this sum exceeded the damage (or "nullification or impairment" of benefits) that the US suffered under the *modified* banana regime. An arbitration panel agreed and authorized the US to apply only US$191 million in sanctions, which the US did in April 1999. Ecuador was also authorized to apply sanctions after a similar experience.[2]

The record of the DSP presented above reflects the workings of two basic principles: conciliation and reciprocity. Conciliation is the idea that countries should try to settle disputes on their own whenever possible, through bilateral negotiations, instead of invoking the formal mechanisms of the DSP. According to the principle of reciprocity, the ultimate goal of the DSP, and especially DSP-approved sanctions, is the restore the balance of concessions. These two principles will be central in our attempts to model the DSP and its effects on trade cooperation.

The approach taken in this paper is to examine the form of optimal international trade agreements, both in the absence and presence of a DSP, using an infinitely-repeated version of standard two-by-two noncooperative tariff game due to Scitovszky (1942) and Johnson (1953–1954). At the outset of the game, the countries write down an agreement, defined as a pair of history-dependent strategies to be implemented over the infinite time horizon. Agreements cannot be enforced externally, so only agreements which are noncooperative equilibria will be implemented. In a typical equilibrium, countries will prevent each other from pursuing protectionist policies by threatening each other with retaliatory sanctions, usually harmful to both sides. An optimal trade policy agreement will achieve the lowest levels of protection and the most severe credible threat. The key distinction between agreements with and without DSP is the degree of communication available after the on-set of the game.

When no intra-game communication is possible, each country's expectation about what the other country will do in any contingency depends solely upon the agreement reached prior to the game. This can be thought of as the case of a degenerate DSP or no DSP. In this case, there is no limit on the severity of the

[2] A famous pre-WTO example is the "Chicken War" of the 1960s. This dispute over EC tariffs on US poultry ended in GATT-authorized sanctions acceptable to both sides. Thus according to Conybeare (1987), "the possible cooperation-inducing effects of many rounds of retaliation and counter retaliation by parties using contingent strategies of retaliation were thereby relinquished".

sanctions that can be threatened, except that each country have an incentive to carry out its part, given the strategy of the other. As autarky is a stage-game Nash equilibrium, infinite reversion to the autarkic equilibrium is the severest equilibrium punishment and thus supports the lowest tariffs of any agreement.

When communication is possible after an agreement has begun (which is a fair representation of most modern trade agreements), these results may differ substantially; however, the rules under which countries communicate and take joint action are of utmost importance. This is where the DSP comes in. We model the DSP as a rule specifying outcomes to follow violations of the agreement in accordance with WTO conventions of conciliation and reciprocity. It will be shown that by imposing a consistency requirement on the DSP, optimal tariff agreements that support cooperation exist, have a structure similar to the optimal agreements without the DSP, and are "renegotiation-proof" in the sense of Pearce (1987). However, the presence of a DSP unambiguously reduces the welfare each country receives in the optimal tariff agreement, relative to the no DSP case, and it *makes the achievement of free trade impossible*, for any amount of discounting.

Central to these results is the difference in the role of discounting in each case. For a given threat of sanctions, the less countries discount the future, the less significant is the short-term temptation to deviate from an agreement relative to the long-term cost associated with its punishment equilibrium. Without a DSP, a smaller relative temptation enables greater cooperation, which takes the form of lower tariffs (unless trade is already free). In the presence of a DSP, however, a smaller relative temptation provides countries with the opportunity to reduce the severity of the punishments. Thus, improvements in cooperation due to lower discounting are mitigated.

Although most of the results obtained here are for the case of ad valorem tariffs, we also consider quotas. In contrast to the tariff case, it is shown that free trade can be achieved for low enough discounting, even with a DSP. However, if countries had a choice, they would always renegotiate to a tariff-based punishment.

Many of the results of this paper are drawn from Ludema (1990). While the literature has progressed considerably since then, the emphasis on conciliation and reciprocity in dispute settlement continues to set this work apart. Hungerford (1991), Kovenock and Thursby (1993), and Maggi (1999) emphasize the information gathering and transmission role of a DSP. Kovenock and Thursby (1993) also model a DSP as a vehicle for instilling "international obligation" in WTO members. Maggi (1999) focuses on the role of a DSP as facilitator of multilateral enforcement. Rosendorff (1999) considers a DSP as a form of insurance against random political fluctuations. Reciprocity and its role in the renegotiation of trade agreements is examined in detail by Bagwell and Staiger (1999), although they do not consider enforcement issues.

The remainder of this paper is divided into several sections. Section 2 sets out the basic static model that has traditionally been used to study the issue of tariffs and retaliation. Section 3 recasts it as repeated game. Section 4 examines optimal tariff agreements in the absence of a DSP, as a benchmark for Section 5. Section 5 introduces the DSP and finds optimal tariff agreements in this context. In Section 6, the results obtained for tariffs are contrasted with the analogous results for the case of quotas. Section 7 concludes.

2. The stage game

We consider a world divided into two countries, 1 and 2, producing two goods, A and B, under conditions of perfect competition and constant returns to scale. In each country, the government is assumed to levy an ad valorem tariff on imports in an effort to maximize welfare. Welfare is taken to be a continuously differentiable, quasi-concave social welfare function defined over consumption of A and B. Both countries are assumed to be large enough so that tariffs influence the terms of trade. To insure that the offer curves have the conventional shape, we allow no domestic distortions or inferiority in consumption and assume a unique trading equilibrium for any combination of tariffs.

Take good B as the numeraire, and let p_i denote the domestic price of good A in country i. Let $x_i \in X_i$ denote the tariff in country i and π, the terms of trade. In the absence of other transport costs, these variables are related by:

$$p_1 = \pi(1+x_1), \quad p_2 = \frac{\pi}{1+x_2} \tag{1}$$

Let the autarky prices of good A, denoted P_i, be such that $P_1 > P_2$. When $p_1 \le P_1$ and $p_2 \ge P_2$, country 1 imports good A and exports good B to country 2. The (just) prohibitive tariffs are defined by:

$$z_i(x_j) = \left(\frac{P_1}{P_2}\right)\left(\frac{1}{1+x_j}\right) - 1 \qquad i,j = 1,2, \quad i \neq j \tag{2}$$

Since $z_i(x_j)$ (possibly infinite) equates (P_1/P_2) with (p_1/p_2), it is the smallest tariff large enough to bring about autarky in the presence of a foreign tariff x_j. By imposing $z \equiv z_i(0)$, either country can unilaterally guarantee autarky, given any non-negative tariff by the other. In what follows, we assume strategy sets, $X_i \equiv [0, z]$. There is no reason to consider tariffs larger than z, since they only continue autarky. Ruling out tariffs less than zero is a less trivial assumption, but it enables a much cleaner representation of the payoffs and corresponding results.

Welfare can be written in implicit form as a continuous function of the tariffs levels: $W_i = W_i(x_1, x_2)$, with welfare in autarky normalized to zero, i.e., $W_i[z_1(x_2),$

$x_2] = W_i[x_1, \ z_2(x_1)] \equiv 0$ for $i = 1,2$.[3] A government maximizes welfare at its optimal tariff $y_i(x_j)$, where

$$y_i(x_j) = \frac{1}{\varepsilon_j - 1} \qquad i,j = 1,2, \quad i \neq j \tag{3}$$

Here ε_j denotes the elasticity of j's import demand with respect to a change in the terms of trade, which is greater than 1 in the neighborhood of the optimal tariff. Let $\omega_1(x_2) \equiv W_1[y_1(x_2), \ x_2)]$ and $\omega_2(x_1) \equiv W_2[x_1, \ y_2(x_1)]$ be the welfare each country associates with its optimal tariff, as a function of the tariff imposed by the other country.

From the assumptions made so far, three well-known results follow. For any nonprohibitive tariff x_j: (1) W_i is quasi-concave in x_i, increasing in x_i up to $y_i(x_j)$, decreasing thereafter to $z_i(x_j)$, and further increases in x_i merely continue autarky and hence are partially ordered (Bhagwati and Kemp, 1969); (2) W_i is nonincreasing in x_j (e.g. see Jones, 1969), and by the envelope theorem, $\omega_i(x_i)$ is also nonincreasing; and (3) the function $y_i(x_j)$ is single-valued, continuous, strictly positive and nonprohibitive. It will also be convenient to assume that world welfare $(W_1 + W_2)$ is quasi-concave and $\omega_i(x_j)$ is convex.[4]

Result (3) above implies the existence of at least one an interior Nash equilibrium $(x_1^n, \ x_2^n)$, where $x_i^n = y_i(x_j^n)$ for $i, \ j = 1,2, \ i \neq j$. There will also typically be a corner solution. In autarky, the elasticity of import demand is infinite, so $y_i(z) = 0$; however, the optimal tariff in this case is not unique. Indeed, any positive tariff, including $x_i = z$, is a best response to $x_j = z$. This implies that autarky is a Nash equilibrium outcome, though the equilibrium strategies that bring about autarky are weakly dominated.[5]

Fig. 1 illustrates the best reply mappings, the prohibitive tariffs, and the Nash equilibria of the stage game. This is shown for the special case in which the optimal tariff functions are monotonic and symmetric. The autarky equilibrium (z, z) is denoted A, and the interior Nash equilibrium is at N. In general, multiple interior equilibria are possible, as demonstrated by Johnson (1953–1954).

That autarky may be a Nash equilibrium in the stage game is both problematic and useful. Nash equilibrium refinements generally rule out equilibria in weakly dominated strategies on the grounds that they are, in a sense, unstable. In our case, the state of almost autarky is not almost a Nash equilibrium, because the best response to an almost prohibitive tariff is an almost zero one. However, this

[3] Since a country can never inflict anything worse than autarky on its neighbor, the minimax payoff for both countries is not less than zero.

[4] This will always hold when the proportional change in ε_i in response to a small change in x_i is not too large. It is trivially satisfied by the well-known constant offer curve elasticity example used by Johnson (1953–1954).

[5] The strategy z is dominated for i because no other x_i is worse than z for any x_j, and some x_i are better for some x_j.

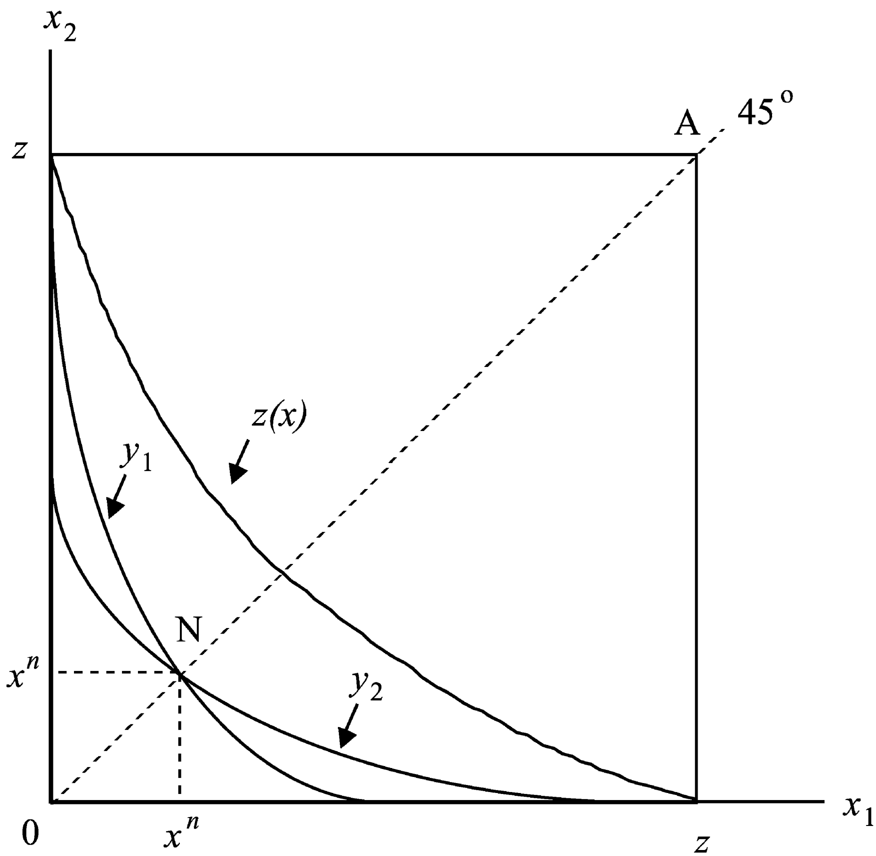

Fig. 1. Nash equilibrium tariffs in the stage game.

instability does not carry over to the repeated game, as noted by Dixit (1987). Moreover, this equilibrium is useful because it is worst possible outcome any country can experience, and thus it is an ideal sanction. Ludema (1990) has shown that autarky will generally be used as an equilibrium sanction in an optimal tariff agreement, even when z is not feasible (i.e., even if the autarkic stage-game Nash equilibrium is ruled out by an exogenous limitation on the strategy sets). Thus, it is without loss of generality that we permit autarky as a Nash equilibrium, and proceed to use it in the repeated game.

3. The repeated game

In this section, we consider the infinitely repeated version of the game just described. Let s_t denote a pair of tariffs (x_{1t}, x_{2t}) in period t, for $t = 0,1,2,\ldots$

Over time there will develop an infinite sequence of such pairs, $s = \{s_t\}_{t=0}^{\infty}$, called an *outcome path*. The welfare associated with an outcome path s will be the sum of the welfare attained at each stage discounted by the factor $\delta \in (0,1)$ and normalized by $(1-\delta)$:[6]

$$w_i(s) = (1-\delta)\sum_{t=0}^{\infty}\delta^t W_i(s_t) \tag{4}$$

A pure *strategy* for government i is an infinite sequence of functions, $\sigma_i = \{\sigma_{it}\}_{t=0}^{\infty}$, where each σ_{it} maps the history of all tariffs played by both countries up through period $t-1$ into a tariff $x_{it} \in X$. We will call a pair of strategies $\sigma = (\sigma_1, \sigma_2)$ an *agreement* (how agreements are reached will be explained later). If followed indefinitely, the agreement σ will completely determine an outcome path $s(\sigma)$ and with it a payoff for each country $w_i[s(\sigma)]$. If ever a country were to deviate from the agreement, by choosing $x_{it} \neq \sigma_{it}$ in some period t, and resume compliance with σ thereafter, it would disrupt the initial outcome path $s(\sigma)$ and begin new path, call it $s'(\sigma)$. A second deviation would induce yet another path $s''(\sigma)$ and so on. It can be shown that one-shot deviations of this kind are the only ones that need to be considered.[7] Hence, an agreement can be fully described by a rule specifying an initial outcome path and outcome paths to be followed after any deviation.

Now consider three outcome paths, an initial path s^0, and two punishment paths s^1 and s^2, and the following rule: (1) choose s^0 for all t, until a country deviates; (2) if country i deviates from any ongoing path, start (or restart) the path s^i; and (3) ignore simultaneous deviations. Together these constitute an agreement.[8] The initial path s^0 is followed as long as no deviation occurs, while the two punishment paths s^1 and s^2, are used whenever one country deviates. If country i deviates at any time, regardless what path is in progress, the path s^i is begun. Such an agreement is a subgame perfect equilibrium (SPE), if no country has an incentive to deviate from any path specified by the agreement, whether initial or punishment. Thus in an SPE, the initial path will always prevail, supported by the credible threat of moving to a punishment path. The initial path will contain the "cooperative" behavior that we wish to support (low or no tariffs), while the punishment paths support that behavior through low payoffs (high tariffs) in the event of deviation.

Let $\omega_i(s_t)$ be the single-period welfare of country i from selecting its optimal tariff in period t in response to $x_{jt} \in s_t$, and let $w_i(s;t) \equiv (1-\delta)\sum_{\tau=0}^{\infty}\delta^{\tau}W(s_{t+\tau})$

[6] This normalization facilitates comparison between repeated game and stage game payoffs.

[7] In equilibrium, if a one-shot deviation is not optimal, then a multi-period deviation is not optimal either. See Abreu (1983) for proof.

[8] Abreu (1988) shows that every pure strategy SPE path is the outcome of an agreement of this form.

denote the normalized welfare from following path s indefinitely, evaluated beginning at time t. A necessary and sufficient condition for an agreement of the form above to be an SPE is:

$$w_i(s^j;t) \geq (1-\delta)\,\omega_i\left(s_t^j\right) + \delta w(s^i) \tag{5}$$

for all $i = 1,2$, all $j = 0,1,2$ and all t. The left side of Eq. (5) represents the country i's payoff (evaluated at t) to remaining on the ongoing path s^j forever. The right side is the sum of the immediate payoff in period t to deviating from the ongoing path and the (discounted) punishment payoff. The punishment payoff term on the right side is discounted, because the change of paths from the ongoing path to s^i does not take place until the period following a deviation.

Existence of an SPE is ensured by the existence of a Nash equilibrium in the stage game: an agreement to simply repeat the static Nash equilibrium each period regardless of history satisfies Eq. (5). Uniqueness is rare. In fact, the Folk Theorem (Fudenberg and Maskin, 1986) says that for a sufficiently high discount factor, *any* combination of individually rational average payoffs can be supported as an SPE.

4. Optimal tariff agreements without dispute settlement

As a benchmark for examining the effects of dispute settlement, we consider optimal tariff agreements without dispute settlement. Suppose countries can meet and reach agreements prior to the game but, for lack of dispute settlement procedures, are unable to communicate after the game has begun. An agreement satisfying subgame perfection will be self-enforcing, but given the non-uniqueness of SPE agreements, the selection of "optimal" tariff agreements prior to the game must be made on criteria other than self-enforcement. The approach taken here is to suppose countries select a bargaining solution on the set of Pareto optimal SPE agreements. The simplest (though not necessarily most realistic) way to do this is to assume the countries possess a certain degree of symmetry, so that bargaining theory would direct us to equal division of world welfare along the initial path. Therefore, we assume the functions $W_i(\cdot)$ for $i = 1,2$ are symmetric, i.e., $W_1(x', x'') = W_2(x'', x')$ for all x', x'' (subsequently, the subscript i will be dropped whenever a variable is equal for both countries and $W_i(x, x)$ will be written as simply $W(x)$). This implies $W(x)$ is strictly decreasing in x, except at $x = 0$, where equal changes in x_1 and x_2 have off-setting terms of trade effects, and this allows us to treat free trade as the ultimate goal of cooperation.

For high enough δ, the immediate gain from deviating from free trade is swamped even by the slightest punishment. Under such circumstances, no agreement can do better than one specifying free trade along the initial path and mild punishment paths; however, this is only true for high discount factors. A better definition of an optimal agreement is one that maximizes initial path payoffs for

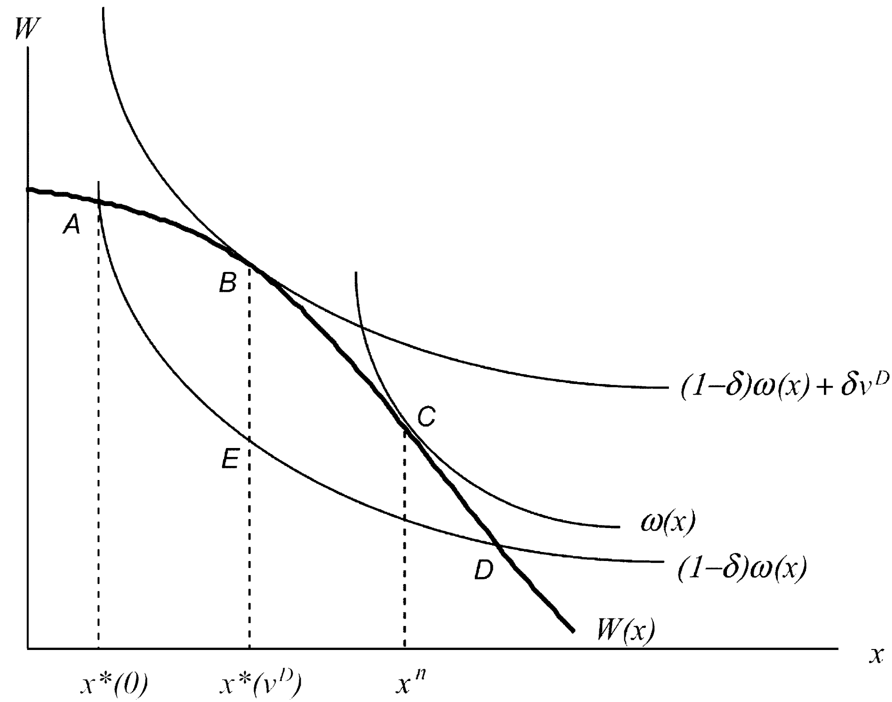

Fig. 2. Optimal tariff agreements without DSP (point A) and with DSP (point B).

an arbitrary discount factor. Thus, we define an optimal tariff agreement to be one that maximizes $w_i(s^0)$ subject to $w_i(s^0) = w_j(s^0)$ and Eq. (5) for any δ.

Let $v_i = v_i(\delta)$ be the lowest normalized payoff country i can receive in any SPE for discount factor δ. By the symmetry of the welfare functions $v_1 = v_2 = v$. Any punishment path resulting in v for either country is the most severe credible punishment path available for that country and thus can support the most cooperation. Let $x^*(v)$ maximize $W(x)$, subject to $W(x) \geq (1-\delta)\omega(x) + \delta v$. An agreement specifying $x^*(v)$ for both countries everywhere along the initial path, and specifying equilibrium punishment paths resulting in v for each country is optimal tariff agreement.[9]

The problem of characterizing optimal tariff agreements is now reduced to finding the punishment paths that give rise to the lowest possible SPE payoffs. As autarky is a stage-game Nash equilibrium, this problem is easily solved. Autarky forever is both subgame perfect and the most severe possible punishment, since zero is the minmax payoff. Thus an optimal agreement for any value of the

[9] Given the quasi-concavity of $W_1 + W_2$ and the convexity of $\omega_i(x)$, the optimality of stationary and symmetric paths follows from Lemma 1 of Abreu et al. (1993), and Lemma 3.3 of Abreu (1983).

discount factor is one which asks both countries to impose the lowest tariff that can be supported by autarky forever, $x^*(0)$. Free trade will be attainable with such an agreement for δ satisfying:

$$\delta \geq \frac{\omega(0) - W(0)}{\omega(0)} \tag{6}$$

The right-hand side of Eq. (6) is the lowest possible δ for which free trade can be supported by any agreement. For δ less than this, the initial path of optimal tariff agreement will satisfy SPE constraint with equality or,

$$W[x^*(0)] = (1-\delta)\,\omega[x^*(0)] \tag{7}$$

This is illustrated in as point A in Fig. 2. All points along the curve $ABCD$ are SPE initial-path payoffs supportable by the autarkic punishment. Point A obtains the lowest tariffs and highest payoffs of any SPE. Point C is the stage-game Nash equilibrium, which is an SPE for any δ. Point B will be explained in Section 5.

5. Optimal tariff agreements with dispute settlement

If there exists a mechanism through which countries can resolve their differences after the game has begun, the optimal tariff agreements of the previous section appear tenuous. Imagine, for example, an agreement has been reached supporting free trade, using the threat of eternal autarky. Suppose also a country deviates from this agreement, taking its one-period optimal tariff welfare over free trade. It is now time for retaliation-autarky forever. Clearly, both countries have an incentive to resolve this problem peaceably and “renegotiate” to a state of at least some trade. However, if countries can return to free trade, then the threat which made free trade possible is no longer there, and free trade is impossible. Hence, in an environment where renegotiation is possible, the only credible threats are those that can be expected to arise from the renegotiation process. Such agreements are said to be “renegotiation-proof”.

Unlike subgame perfection, there is no widely accepted condition for renegotiation-proofness. Various authors have advanced notions (e.g., Pearce, 1987; DeMarzo, 1988; Farrell and Maskin, 1989; Bernheim and Ray, 1989; Abreu et al., 1993), each one differing in the type of group behavior considered to be “reasonable.” In this respect, the multiplicity of approaches resembles the multiplicity of solution concepts for cooperative games.[10] It would appear which

[10] DeMarzo (1988) has drawn this analogy: “classical cooperative game theory has demonstrated that once we allow group defections, no single, comprehensive, and universally compelling equilibrium concept is likely to emerge. Stable sets, the Core, and the Shapley Value among others have all proved useful in various contexts. Thus, it is not surprising that a non-cooperative game theory expands to encompass varying degrees of communication and coordination between players, different solution concepts will also emerge”. Also see Greenberg (1987).

concept of renegotiation-proof equilibrium is appropriate depends upon the context in which agreements are renegotiated. Here we are fortunate in that within the context of international trade agreements, such as the WTO, well-defined institutions for assigning of trade sanctions following a breach of the agreement exist: we will refer to these generally as dispute settlement procedures. Rather than advancing a theory of reasonableness of collective action, the approach taken here is to write down a DSP, which amounts to a rule assigning punishments satisfying certain criteria. We then look for optimal tariff agreements subject to the DSP.

The WTO dispute settlement procedure is based on Article XXIII of the GATT and detailed in the 1994 Dispute Settlement Understanding. Its intent is to enable countries to consult each other on trade matters, rather than act unilaterally; to enforce agreements; and to restore of the balance of concessions, or reciprocity.[11] Countries must negotiate prior to any retaliation. At any time, a dispute settlement panel may be set up at the request of either country to determine whether or not an offending policy represents a violation of the WTO rules. Panel decisions may be appealed. If a country refuses to revoke a policy found to be in violation, then sanctions can be authorized. As the banana case illustrated, however, a country in violation can also modify its policy, and the sanctions cannot exceed the damage inflicted by the modified policy. Thus, subject to reciprocity, the violating country can all but choose the level of sanctions against it.

In this model, we can abstract from many details of the DSP, because of the assumption of perfect information. Tariffs other than the ones specified by the initial path can be observed, are by definition in violation of the agreement and, hence, must constitute an invitation to sanctions. Clearly, this simplification diminishes the applicability of the model to actual WTO practice, but it helps to bring our point into focus.

Suppose countries can negotiate agreements, subject to the rule that any violation of the agreement be governed by the DSP. The DSP specifies a punishment path with the same properties as the original agreement and satisfies:

1. Subgame perfection: no country has an incentive to unilaterally deviate.
2. Reciprocity: each country receives equal welfare from the path.[12]
3. Consistency: the same path is specified whether it is due to a deviation from the initial path or a previous punishment path.[13]

[11] This characterization of DSP objectives is due to Jackson and Davey (1986). The last is echoed by Long (1985): "... the objective is to restore, with the minimum interference with trade, the balance of concessions and advantage between the parties in the dispute. Conciliation is a key factor in the procedure".

[12] This is slightly weaker than symmetry, which is period-by-period equality of welfare.

[13] This might be thought of as a rule of precedent. Jackson and Davey (1986, p. 332) write, "Even though strict 'stare decisis' concepts of precedent do not apply... sometimes the deliberations of international dispute settlement panels or arbiters give every bit the appearance of common law lawyers arguing precedent".

4. Conciliation: at no time would any country ask for an alternative path satisfying 1–3.

A punishment path satisfying these rules is renegotiation-proof in the sense of Pearce (1987).[14] According to Pearce, a punishment equilibrium should be Pareto optimal on the set of subgame perfect equilibria that rely on no punishments worse than themselves. To say that is it possible to choose (through renegotiation) a punishment equilibrium α, which is supported by another punishment equilibrium β, where β is worse (for both players) than α, is to say that α is not an equilibrium, because if anyone were to deviate from α, then β (which supports α) would be abandoned in favor of α through renegotiation. Only when β is no worse than α can this inconsistency be avoided. The above four conditions on dispute settlement outcomes satisfy Pearce's criterion: subgame perfection (1) is the minimum requirement for self-enforcement; by restricting attention to reciprocal punishment paths (2), the conciliation requirement (4) reduces to Pareto efficiency; and the consistency requirement (3) implies that the punishment path is supported by itself, rather than an equilibrium worse than itself.

Optimal tariff agreements are negotiated prior to the start of the game subject to the DSP. Again we look for the best, self-enforcing, initial path that gives the countries equal welfare. Let v^{D} be the payoff to a punishment path satisfying 1–4, and let $x^{\mathrm{D}} = x^*(v^{\mathrm{D}})$. Now consider the following path:

$$q = \left\{ (x^n, x^n)_{t=0}^{T-1}, q_T, (x^{\mathrm{D}}, x^{\mathrm{D}})_{t=T+1}^{\infty} \right\} \tag{8}$$

where q_T is a randomized tariff pair, taking on value x^n with probability λ and x^{D} otherwise.[15] Along this path, both countries choose Nash equilibrium tariffs for T periods, followed by q_T, and then choose the cooperative (i.e., lowest supportable) tariffs x^{D} thereafter. With discrete time, countries are restricted to choosing integers for the length of their Nash reversion, rather than any real number. This is the sole purpose of q_T.

Proposition 1. *There exists a punishment path q^D of the form (8) satisfying conditions 1–4. An agreement specifying $s^0 = \{x^D, x^D\}_{t=0}^{\infty}$, $s^i = q^D$, for i = 1,2 is optimal given the DSP. Proof in Appendix.*

In the absence of a DSP, it was shown that interior stage-game Nash equilibria would generally not play a role in the optimal tariff agreement, because they are

[14] This is extended to the concept of Consistent Bargaining Equilibrium by Abreu et al. (1993) and Abreu and Pearce (1991).

[15] It is assumed there exists a publicly observable random variable with a continuous distribution. Then by choosing actions in T according to the realization of the random variable, countries can choose autarky with any probability $\lambda \in [0,1]$ and $x^*(v)$ with probability $(1-\lambda)$. Strictly speaking the equilibria found here are correlated, as in Aumann (1974). This one way to convexify the problem when the integer constraint is binding.

neither good enough to be part of the initial path nor bad enough to be part of the punishment path. Instead, autarky would generally be used in the punishment path. In the presence of a DSP, however, interior stage-game Nash equilibria can be used in the punishment path. A path that repeats a symmetric stage-game Nash equilibrium indefinitely satisfies conditions 1–3 of the DSP, but not 4. By restricting the time spent in the Nash equilibrium to T periods, the payoff to the punishment path exceeds that of indefinite repetition of the stage-game Nash equilibrium. Of course, T cannot be too small or q^{D} would not support x^{D}.

The optimal tariff agreement values, x^{D}, T^{D} and λ^{D}, can be found by maximizing the welfare of the punishment path,

$$v^{\mathrm{D}} = \max_{x,T,\lambda}\big\{(1-\delta^{T})W(x^{n}) + (1-\delta)\,\delta^{T}[\lambda W(x^{n}) + (1-\lambda)W(x)] + \delta^{T+1}W(x)\big\} \tag{9}$$

subject to the perfection conditions (Eq. (5)). This can be simplified somewhat by combining T and λ into a single variable, $\Lambda = T + \{\ln[\delta\lambda + (1-\lambda)]/\ln(\delta)\}$, which we shall call the *effective punishment length*. It is approximately equal to $T+\lambda$, the expected number of periods of Nash reversion on the punishment path (this approximation becomes exact as δ approaches one). Using Λ in Eqs. (9) and (5) enables us to write the problem as

$$v^{\mathrm{D}} = \max_{x,\Lambda}\big[(1-\delta^{\Lambda})W(x^{n}) + \delta^{\Lambda}W(x)\big] \tag{10}$$

subject to

$$W(x) \geq (1-\delta)\,\omega(x) + \delta\big[(1-\delta^{\Lambda})W(x^{n}) + \delta^{\Lambda}W(x)\big] \tag{11}$$

$$W(x^{n}) \geq (1-\delta)\,\omega(x^{n}) + \delta\big[(1-\delta^{\Lambda})W(x^{n}) + \delta^{\Lambda}W(x)\big] \tag{12}$$

Condition (11) guarantees that neither country would wish to deviate from the initial path, while condition (12) ensures that neither country would wish to deviate from the punishment path. Noting that $\omega(x^{n}) = W(x^{n})$ by the definition of Nash equilibrium, we see that Eq. (12) is satisfied trivially. Intuitively, this is because in the early periods of the punishment path, countries are playing their stage-game Nash tariffs, from which there is no incentive to deviate. There is, in fact, a real cost to deviation in that it results in the reimposition of the punishment path, thereby postponing the return to x^{D}. In the later periods of the punishment path, countries are playing x^{D}, just as on the initial path. As Eq. (11) guarantees that x^{D} is supportable, Eq. (12) is redundant.

One perhaps instructive way of looking at the solution to the above problem is illustrated in Fig. 3. Let $q(\Lambda)$ be a punishment path of the form (8), with Λ as its effective punishment length. The payoff to this path is $w[q(\Lambda)]$, and let $x^{*}(\Lambda) = x^{*}\{w[q(\Lambda)]\}$ be the associated cooperative tariff. At $\Lambda = 0$, $x^{*}(\Lambda)$ is equal to x^{n}, because the absence of punishment undermines any cooperation. As Λ increases,

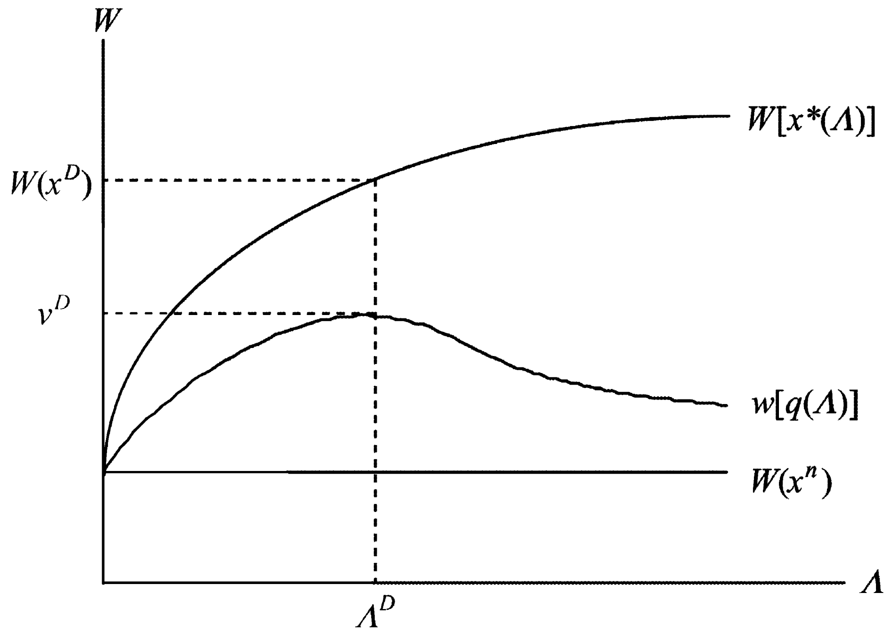

Fig. 3. Punishment length is chosen to maximize punishment payoff.

$x^*(\Lambda)$ falls and the associated cooperative welfare $W[x^*(\Lambda)]$ rises, as illustrated in Fig. 3.

The punishment payoff $w[q(\Lambda)]$ is just a weighted average of the payoff from cooperation $W[x^*(\Lambda)]$ and the payoff from Nash reversion $W(x^n)$, as seen in Eq. (10). Setting $\Lambda = 0$ puts all the weight on the cooperative payoff, but since there is no cooperation with $\Lambda = 0$, we have $w[q(\Lambda)] = W[x^*(\Lambda)] = W(x^n)$. As Λ approaches infinity, all the weight is on $W(x^n)$, and so once again $w[q(\Lambda)] = W(x^n)$. Somewhere in between these two extremes $w[q(\Lambda)]$ reaches a maximum v^{D}. This point is labeled Λ^{D} in Fig. 3. It is the optimal punishment length, as it supports the highest, consistent, reciprocal, SPE, punishment payoff. We should also point out that Λ^{D} may be less than one. That is, there may be no punishment at all (though there must be always a positive probability of at least a period of punishment).

Several interesting results follow. Perhaps the most important result is that free trade can never be reached on the initial path of an agreement, when there is a dispute settlement procedure of the form described above. To see this, note that the constraint (11) must always be binding, since if it were not the countries could reduce Λ and increase the payoff v^{D}. That is, if the punishment were more than enough to support free trade, the countries would certainly want to shorten the effective punishment length. Given this, the optimal initial-path tariff x^{D} must satisfy a first-order condition of the Lagrangean, consisting of Eqs. (10) and (11) (the latter holding with equality), which reduces to

$$\frac{\mathrm{d}W(x^{\mathrm{D}})}{\mathrm{d}x} = (1-\delta)\frac{\mathrm{d}\omega(x^{\mathrm{D}})}{\mathrm{d}x} \tag{13}$$

If $\delta < 1$, then this condition cannot hold at free trade, because $\mathrm{d}W(0)/\mathrm{d}x = 0$ and $\mathrm{d}\omega(0)/\mathrm{d}x < 0$. Intuitively, the argument is this: at free trade, a small increase in x has no first order effect on welfare but reduces the one-period payoff from deviation, resulting in a total punishment payoff that is more than enough to support x. But this means the countries can now shorten the effective punishment length and thereby increase v^{D}. Hence, the countries would always prefer a small, positive tariff to free trade, as the former enables a lighter punishment.

Condition (13) is illustrated at point B in Fig. 2. The total payoff to deviation under the DSP is $(1-\delta)\omega(x) + \delta v^{\mathrm{D}}$. This is drawn in Fig. 2 as a function of x, holding constant v^{D} (appropriate adjustment of the punishment length can hold v^{D} constant for any $x < x^n$). This curve is parallel to $(1-\delta)\omega(x)$, the payoff to deviation without dispute settlement, with the distance between B and E equal to δv^{D}. The DSP chooses the highest possible v^{D} subject to the SPE constraint, which occurs at the point of tangency between $(1-\delta)\omega(x) + \delta v^{\mathrm{D}}$ and $W(x)$. It is clear that for $\delta \in (0, 1)$, the DSP produces lower initial path welfare, more lenient punishments and higher tariffs than the case without dispute settlement.

Much of the effort that has gone into DSP reform in recent years has focused on making it more streamlined and objective, so as to increase the speed and accuracy with which violations are detected and evaluated.[16] One reasonable way to model the impact of such reforms is as an increase in the discount factor, as δ can be interpreted either as a measure of the patience of the policymakers or the speed with which they can respond. Thus, it might be worth exploring the performance of trade agreements under the DSP as δ is increased. Total differentiation of Eq. (13) yields,

$$\frac{\mathrm{d}x^{\mathrm{D}}}{\mathrm{d}\delta} = \frac{-\dfrac{\mathrm{d}\omega(x^{\mathrm{D}})}{\mathrm{d}x}}{\dfrac{\mathrm{d}^2W(x^{\mathrm{D}})}{\mathrm{d}x^2} - \dfrac{\mathrm{d}^2\omega(x^{\mathrm{D}})}{\mathrm{d}x^2}} < 0 \tag{14}$$

The numerator of Eq. (14) is positive, while the denominator is negative, the latter by the second-order condition of Eq. (10). Thus, as one would hope, cooperation is enhanced by increases in the discount factor. We can go further than this and consider what happens as $\delta \to 1$. This is found in Proposition 2.

[16] Other measures, such as the Trade Policy Review Mechanism, serve a similar purpose.

Proposition 2. *As δ approaches the limit of unity, $x^D \to 0$, $v^D \to W(x^D) \to W(0)$ and $\delta^A \to 1$. Proof in Appendix.*

Thus, as the response time disappears, the optimal tariff agreement approaches free trade. The "drag" that the DSP exerts on the optimal tariff agreement becomes irrelevant. This is true despite the fact that the punishment payoff converges to the cooperative payoff.

Finally, it should be pointed out that the above results are not necessarily robust to alternative concepts of renegotiation-proof equilibrium. One of the key features of the present DSP is reciprocity, an essential principle of GATT (Bagwell and Staiger, 1999). Some renegotiation-proof equilibrium concepts, most notably Farrell and Maskin (1989), rely on asymmetric punishments to support cooperation, and hence in the presence of reciprocity would allow no cooperation at all. Asymmetric punishments, as used in Cotter and Mitchell (1990), will typically require a deviating country to atone for its indiscretion by eliminating its trade barriers, while allowing the other country impose a high tariff upon it for several periods. This relies on the implicit assumption that renegotiation, if it were to ever occur, would always be resolved in favor of the punishing country. The Pearce notion of renegotiation-proof equilibrium is consistent with the assumption that bargaining power is equal in renegotiation.[17]

6. Tariffs vs. quotas

No good commercial policy paper would be complete without a moment of reflection on the equivalence (or lack thereof) of tariffs and quotas. Rodriguez (1974) and Tower (1975) used the static model of Section 2 to demonstrate that tariffs and quotas give rise to substantially different outcomes in the Nash equilibrium. In particular, when quotas instead of tariffs are used as the strategic variable, the unique Nash equilibrium outcome is autarky. To see why, suppose the two countries have a quota arrangement whereby they share the total quota rent equally (this is equivalent to a reciprocal tariff arrangement). Now if one country slightly lowers its quota, it suddenly captures all of the quota rent, and this discrete jump in quota rent outweighs the cost of the marginal reduction in trade from the lower quota. This implies each country's best response to the other country's quota is always a (possibly only slightly) lower quota, except at autarky. Hence, autarky is the only Nash equilibrium.

In international trade agreements, this difference between tariffs and quotas remains important. The one-period gain to deviating from a quota agreement is

[17] See Abreu and Pearce (1991) for more detailed discussion.

generally higher than from the equivalent tariff agreement (based on the above argument). Bagwell and Staiger (1990) have shown that, if eternal autarky is used as the punishment in both types of agreement, then the optimal tariff agreement is weakly superior to the optimal quota agreement. However, if eternal reversion to the interior Nash equilibrium is used instead as the punishment, this ranking may be reversed, as the punishment under a quota agreement (autarky) is more severe.

In the presence of a DSP, it turns out that the optimal quota agreement may also be superior to the optimal tariff agreement. However, the reason has nothing to do with which one-shot Nash equilibrium is used to comprise the punishment path. In the DSP-constrained optimal tariff agreement, the cooperative tariff is determined by condition (13), which is independent of the one-shot Nash equilibrium. This tariff could be equally well supported by a short stint of autarky as a longer duration of the interior Nash equilibrium. Thus, there is no gain in terms of punishment severity per se from using quotas. Rather, the potential superiority of quota agreements stems from the fact that the one-period gain to deviating from a quota agreement is invariant to the quota level for a range of agreements including free trade.

Suppose two countries have a reciprocal quota agreement, and let x^{Q} denote its tariff equivalent. Suppose also that the volume of trade under this agreement is at least as large as under the tariff combination $(y(0), 0)$. That is, we suppose $(1+x^{Q})^2 < 1 + y(0)$. Now if one country were to deviate from x^{Q} by choosing its one-shot optimal quota, then it would receive a one-period payoff of $\omega(0)$—just as if it had imposed a tariff of $y(0)$, while its trading partner had no tariff. This is true for an entire range of x^{Q} including free trade. For all such quota agreements, the one-period payoff from deviation is the same.

In Section 5, we argued that a DSP-constrained tariff agreement could never achieve free trade, because at free trade, a small increase in x has no first order effect on welfare but reduces the one-period payoff from deviation. The consequent slackening of the SPE constraint allowed for a shortening of the punishment length, thereby increasing v^{D}. With a quota agreement, this logic breaks down, because of the invariance of deviation payoff. Instead, free trade becomes possible in the optimal DSP-constrained quota agreement.

Fig. 4 illustrates this possibility. The discount factor is assumed to be high enough so that, in the absence of dispute settlement, the optimal tariff and quota agreements coincide at point A. With the DSP, the optimal tariff agreement moves to point B, as countries increase v^{D} to its maximum sustainable level. The optimal quota agreement, however, remains at point A, as countries increase v^{DQ} (the DSP punishment payoff in the quota agreement) to its maximum sustainable level.

The case examined in Fig. 4 requires a fairly high discount factor. If the discount factor is too low to support free trade without dispute settlement, then a tariff agreement is typically superior to quota agreement, with or without a DSP. Another aspect of this comparison that should give pause is that, even when the DSP-constrained quota agreement obtains free trade, v^{DQ} is always lower than v^{D}.

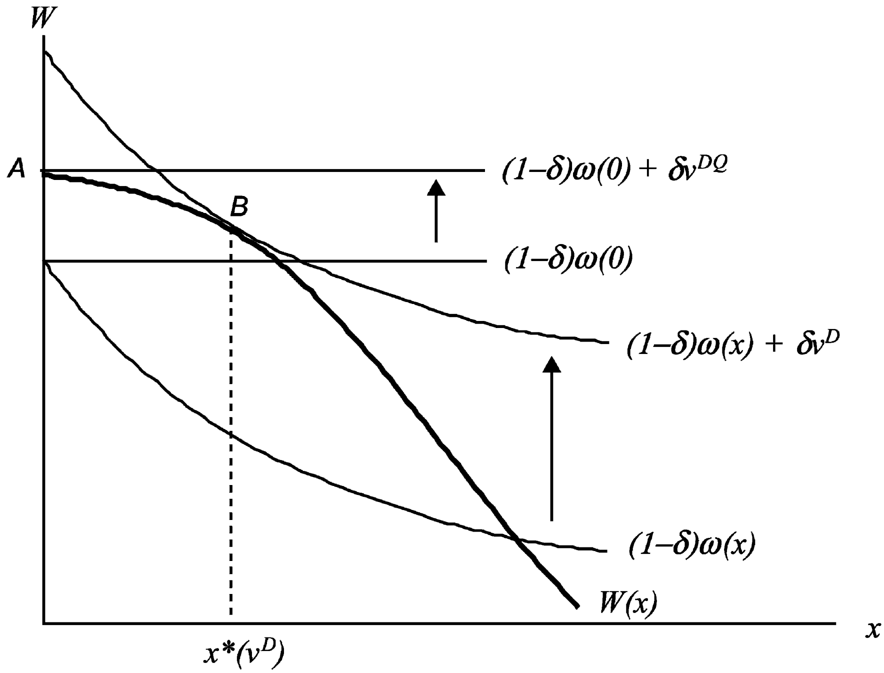

Fig. 4. Quota agreement may achieve free trade even under DSP.

Thus, if the countries had a choice of instrument to use in their punishment under the DSP, they would always choose tariffs.

7. Conclusion

This paper has shown that the renegotiation of punishments implicit in a DSP generally reduces trade policy cooperation relative to no-DSP case. Although this rather depressing result may seem to indicate that the world would be better off without a DSP, such a conclusion would be unwarranted. First, this paper has modeled a DSP based on the WTO principles of conciliation and reciprocity. It has not attempted to model every aspect the WTO's dispute settlement procedure. It has ignored, for example, the undoubtedly valuable roles of information gathering and transmission and the facilitation of multilateral coordination. Second, the no-DSP case is not a realistic option. The fact is that communication is possible and countries have an overwhelming incentive to settle their disputes one way or another, once they arise. Thus, the relevant issue is not whether to have a DSP but how the DSP should be structured. Our model suggests that a fair amount of trade policy cooperation can be sustained, despite a DSP based on conciliation and reciprocity. Moreover, reforms that make response to violations faster and more certain unambiguously increase trade policy cooperation, suggesting that perhaps response time is the best target for DSP reform initiatives.

One common criticism of the type of model used here is that, since no country ever deviates in equilibrium, the phenomenon of trade wars cannot be explained. It is not clear, however, that trade wars are as common as is widely believed, especially since the advent of the GATT. The fact that many dispute settlement cases are begun stems from the fact that actual DSPs serve two functions: that of investigating perceived deviations and of authorizing sanctions. Very few dispute settlement cases ever make it to the sanction stage (three, since 1995). Further, many apparent cases of retaliation may not be deviations at all but attempts to prevent deviations. Bagwell and Staiger (1990) shows that for a given threat of punishment, different states of the world (e.g. import demand surges) result in different incentives to deviate from the initial path, and consequently, an agreement may have to require state-dependent actions (e.g. safeguards), which look like deviations, but are logically quite different. Finally, the most common way to generate trade wars in equilibrium is to assume imperfect monitoring (e.g., Riezman, 1991). While imperfect monitoring can be introduced into the current framework, with relatively minor revisions to the conclusions, it would be difficult to justify this assumption in the context of GATT-bound tariffs and quotas, where communication and monitoring are quite good.

Appendix

Proof of Proposition 1. By condition (4) no path satisfying 1–4 gives the countries less than v^{D}. By the definition of x^{D}, the path s^0 is supported by v^{D}, and, hence, according to footnote 11, s^0 and any SPE s^i, such that $w_i(s^i) = v^{\mathrm{D}}$, is an optimal tariff agreement for any discount factor (subject to the DSP).
As v^{D} supports x^{D}, condition (5) implies $W(x^{\mathrm{D}}) \geq v^{\mathrm{D}}$, and since the path $\{x^n, x^n\}_{t=0}^{\infty}$ satisfies 1–3, it follows that $v^{\mathrm{D}} \geq W(x^n)$. Thus, there exists a path q^{D} with $T \geq 0$ and $\lambda \in [0,1]$, such that,

$$\mathrm{E}w\left(q^{\mathrm{D}}\right) = (1-\delta^T)W(x^n) + (1-\delta)\,\delta^T\left\{\lambda W(x^n) + (1-\lambda)W^{\mathrm{D}}\right\} + \delta^{T+1}W(x^{\mathrm{D}}) = v^{\mathrm{D}}$$

Note that along the path q^{D}, $\mathrm{E}w(q^{\mathrm{D}};\ t+1) \geq \mathrm{E}w(q^{\mathrm{D}};\ t)$, for all t.
The condition for SPE of q^{D} for $t < T$ and $t = T$ if $q_T^{\mathrm{D}} = x^n$ is:

$$(1-\delta)W(x^n) + \delta\,\mathrm{E}w\left(q^{\mathrm{D}};t+1\right) \geq (1-\delta)\,\omega(x^n) + \delta\,\mathrm{E}w\left(q^{\mathrm{D}}\right)$$

which reduces to $\delta\,\mathrm{E}w(q^{\mathrm{D}};\ t+1) \geq \delta\,\mathrm{E}w(q^{\mathrm{D}})$, as $W(x^n) = \omega(x^n)$, by the definition of Nash equilibrium. For $t > T-1$ and $t = T$ if $q_T^{\mathrm{D}} = x^{\mathrm{D}}$, it must be that:

$$W(x^{\mathrm{D}}) \geq (1-\delta)\,\omega(x^{\mathrm{D}}) - \delta\,\mathrm{E}w\left(q^{\mathrm{D}}\right)$$

which is true by the definition of x^{D}. □

Proof of Proposition 2. Show $\lim_{\delta \to 1} W^{D} = W(0)$. Since ω is continuous and finite for all x, $\lim_{\delta \to 1}(1-\delta)\omega_x = 0$. By assumption, $W_x(x) = 0$ only at $x = 0$. Thus, condition (12) is satisfied in the limit, if and only if, $\lim_{\delta \to 1} x^{D} = 0$, which implies $\lim_{\delta \to 1} W^{D} = W(0)$.

We argued in the text that the constraint, $W(x^{D}) = (1-\delta)\omega(x^{D}) + \delta v^{D}$ always binds. We have just established that the right-hand side converges to $W(0)$. Since ω is continuous and finite for all x, $\lim_{\delta \to 1}(1-\delta)\omega(x^{D}) = 0$. It follows that $\lim_{\delta \to 1}\delta v^{D} = \lim_{\delta \to 1} v^{D} = W(0)$. Moreover, as $v^{D} = [(1-\delta^{\Lambda})W(x^{n}) + \delta^{\Lambda}W(x)]$, $\lim_{\delta \to 1} v^{D} = W(0)$ if and only if $\lim_{\delta \to 1}\delta^{\Lambda} = 1$. □

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